#### **Collider Run IIa: Plan for FY2003**

#### **Summary Report**

September 30, 2002

This document contains a high level summary of the plan for improvements to Tevatron Collider performance at Fermilab over the next year (October 1, 2002 through September 30, 2003). While many elements of the plan are already in the process of being implemented, the final version of the plan will be reviewed by the Department of Energy over the period October 28-31, 2002. It is anticipated that adjustments to this plan will be made in preparation for that review, in response to that review, and as changing conditions and experience warrant.

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#### 1. Goals for FY2003

The primary goal for FY2003 is to establish a performance level in the Tevatron Collider consistent with the goal of  $5\times10^{31} \text{cm}^{-2} \text{sec}^{-1}$  as listed on the Main Injector Construction Project Data Sheets. In terms of integrated luminosity this corresponds to  $\sim10 \text{ pb}^{-1}/\text{week}$ . The secondary goal is to evolve the accelerator complex to a configuration to support significantly improved performance in the following year.

The Run IIa goal has been established at  $8 \times 10^{31} \text{cm}^{-2} \text{sec}^{-1}$  a 60% increase beyond the construction project data sheet. This goal is motivated by performance beyond expectations in Collider Run I and does not include recycling of antiprotons at the end of stores (expect to yield another factor of up to 2.5).

These considerations lead to the establishment of "base" and "stretch" goals as:

Base goals: Integrated luminosity of 10 pb<sup>-1</sup>/week by the end of FY03

Integrated luminosity of 200 pb<sup>-1</sup> for FY03

Stretch goals: Integrated luminosity of 15 pb<sup>-1</sup>/week by the end of FY03

Integrated luminosity of 320 pb<sup>-1</sup> for FY03

These goals are motivated by Fermilab's understanding of current performance limitations, by the short term needs of the experimental programs centered on the CDF and D-0 detectors, by resources available, and by the longer term vision of being able to integrate a very significant luminosity (on the order of 10 fb<sup>-1</sup>) by the time of physics turn on of the LHC. Base goals represent approximately a factor of two-and-one-half improvement relative to FY2002, stretch goals a factor of approximately four. Achievement of these goals will position the Tevatron complex for similar improvement in FY2004 as compared with FY2003.

#### 2. Characterization of Current Performance and Strategic Approach

Current performance is at roughly 25% of the Run IIa goal: initial luminosities average  $2.2\times10^{31} \text{cm}^{-2}\text{sec}^{-1}$  with a best luminosity to date of  $3.0\times10^{31} \text{cm}^{-2}\text{sec}^{-1}$ . Current performance and Run IIa goals are characterized in below.

Parameter	Run IIa Goals	Current Performance (ty	<u>pical)</u>
Protons/bunch	2.70E+11	1.70E+11	
Antiprotons/bunch	3.00E+10	1.39E+10	
Total Antiprotons	1.08E+12	5.00E+11	
Peak Antiproton Production Rate	2.00E+11	1.10E+11	pbar/hour
Accumulator -> 150 GeV coalesced efficiency	0.90	0.80	•
MI 150 GeV -> Low β efficiency	0.90	0.60	
Accumulator -> low β efficiency	0.81	0.48	
Proton emittance (95%, norm)	20	20	$\pi$ mm-mr
Pbar emittance (95%, norm)	15	15	πmm-mr
Beta @ IP	0.35	0.35	m
Beam Energy	1000	980	
Bunches	36	36	
Longitudinal Emittance (proton, 95%)	3	6	eV-sec
Longitudinal Emittance (pbar, 95%)	2	4.5	eV-sec
Bunch length (proton, rms)	0.45	0.61	m
Bunch length (pbar, rms)	0.37	0.54	m
Form Factor (Hourglass)	0.70	0.65	
Typical Luminosity	8.1E+31	2.2E+31	cm <sup>-2</sup> sec <sup>-1</sup>
Integrated Luminosity	16.	4.	pb <sup>-1</sup> /week
Bunch Spacing	396	396	nsec

As is evident from the table, current performance is characterized primarily by a 37% shortfall in proton intensity and a 55% shortfall in antiprotons relative to Run IIa goals. At present, the antiproton production rate is not an impediment to peak luminosity performance, nor will it be until the luminosity rises above about  $4\times10^{31} \text{cm}^{-2} \text{sec}^{-1}$ . This is because the average store duration, currently 14.9 hours, is sufficient to allow accumulation of the requisite number of antiprotons at the current stacking rate. However, improved stacking rates will allow more efficient recovery from incidents in which a store is lost unexpectedly.

#### Protons

Proton intensity is currently averaging about  $1.7 \times 10^{11}$ /bunch. The Run IIa goal is  $2.7 \times 10^{11}$ /bunch. The Main Injector is capable of delivering  $3.0 \times 10^{11}$ /bunch. Proton intensities in the Tevatron are limited by a number of factors, given here in decreasing order of importance:

- Beam instabilities are limiting intensities to  $<2\times10^{11}$ /bunch.
- Significant beam loss occurs at 150 GeV due to poor beam lifetime and during the acceleration ramp.
- These performance issues in the Tevatron are exacerbated by anomalous longitudinal emittance growth on the Main Injector acceleration cycle.

Achieving Run IIa performance goals will require the implementation of transverse dampers, control of tunes and couplings at 150 GeV and perhaps through the acceleration ramp, the introduction of octupole magnets, and an increase in the proton-antiproton separation helix—all

in the Tevatron. In addition it is likely that longitudinal dampers will be required in the Main Injector.

#### **Antiprotons**

Antiprotons are currently averaging about  $1.4\times10^{10}$ /bunch. This number is derived primarily as the product of the average number of antiprotons  $(1.0\times10^{12}, 2.8\times10^{10}$ /bunch) extracted from the Antiproton Accumulator and the efficiency for transmission to the collision configuration in the Tevatron (48%). Transmission efficiency through the bunch coalescing process in the Main Injector is roughly 80% and efficiency from the Main Injector through the initiation of collisions in the Tevatron is roughly 60%. A number of issues are limiting performance, all at approximately equal levels:

- Main Injector coalescing efficiency ranges between 75-85%. The Run IIa goal is 90%.
- The antiprotons suffer significant emittance dilution (75-80%) on the Main Injector to Tevatron beam transfer.
- The efficiency of the Main Injector to Tevatron beam transfer is lower (~90%) than the Run II a goal (100%).
- Significant beam loss occurs at 150 GeV due to poor (<2 hour) beam lifetime and during the acceleration ramp.
- These performance issues in the Tevatron are again exacerbated by anomalous longitudinal emittance growth on the Main Injector acceleration cycle.

Achieving Run IIa design intensities will require implementation of injection dampers in the Tevatron, improved optical matching and automated steering control on the Main Injector to Tevatron antiproton transfer line, implementation of longitudinal dampers in the Main Injector, control of tunes and couplings at 150 GeV and perhaps through the acceleration ramp, and an increase in the proton-antiproton separation helix in the Tevatron.

#### **Strategy**

The overall strategy is to implement new hardware and software to address the performance limitations identified with proton and antiproton intensities as described above. Both identification of specific needs and commissioning of new hardware systems will require significant study time. While some studies can be completed without impact on colliding beam operations, it is inevitable that some will come at the expense of integrating luminosity either directly, by reducing colliding beam hours, or indirectly, by utilizing antiprotons for purposes other than collisions.

The operating schedule over FY2003 is divided into three parts:

#### 1. October 1, 2002 – January 5, 2003

The goal for this period is to operate with the current accelerator configuration, augmented by improvements that can be implemented without shutdowns requiring more than a day. During this period we will be devoting on average about three (8 hour) shifts per week to dedicated machine studies. In addition we will be devoting approximately  $1 \times 10^{12}$  antiprotons/week to Recycler commissioning activities. Scheduled downtime will be severely limited with maintenance/repairs undertaken only in response to imminent or actual

equipment failures. The luminosity at the end of this period should be roughly  $4\times10^{31}$  cm<sup>-2</sup>sec<sup>-1</sup> (6.5 pb<sup>-1</sup>/week).

#### 2. January 6, 2003 – February 16, 2003

The goal for this period is to undertake an extended shutdown with the following major goals:

- Replacement of the Lambertson magnets at C-0, associated with the now-decommissioned C-0 abort, with wide aperture, room temperature, dipole magnets. This replacement should allow a 30% increase in the Tevatron beam separation helix.
- Completion of work in the Recycler Ring to allow it to be brought into an operational state without further extended shutdowns.
- Completion of a significant number of installation activities in the Main Injector in support of the NuMI project.
- Completion of significant deferred maintenance activities.

The exact timing of this shutdown is currently under discussion and will probably be finalized in early November. However, there are no circumstances under which this would not happen sometime between January and September 2003.

#### 3. February 17, 2003 – September 29, 2003

The goal for this period is to operate with the new accelerator configuration established during the extended shutdown, while simultaneously commissioning and integrating the Recycler into operations by the end of the period. The luminosity at the end of this period should be roughly  $5.5 \times 10^{31} \text{cm}^{-2} \text{sec}^{-1}$  (10 pb<sup>-1</sup>/week).

It is expected that, with the exception of the extended shutdown, the accelerator complex will be operating in support of the MiniBoone experimental program simultaneous with collider operations.

#### 3. Scope of the plan

The plan summarized below contains elements aimed at improved luminosity performance in the Tevatron to the levels outlined in Section 1. Included in the plan are elements aimed at improving reliability of operations as well as peak performance. Elements of the plan are based on current understanding of performance limitations in the accelerator complex as described in Section 2. Major technical elements are described in Section 4.

This document only summarizes element of the collider FY2003 plan related to improving luminosity performance. Associated studies, performance analysis efforts, reliability initiatives, and resource requirements are not described here although they are included in the comprehensive plan under final preparation.

The plan is aimed at supporting the "base goals" described in Section 1. Base goals are those which we believe can be confidently achieved if the majority of plan elements proceed as anticipated and produce the anticipated performance enhancements. In addition a set of "stretch goals" are established which correspond to completion of essentially all plan elements on schedule with each element producing the anticipated performance enhancements. While the stretch goals correspond to what Fermilab will be working to achieve, and perhaps exceed, in support of the collider program, they cannot now be assigned a high level of confidence for achievement in FY2003.

#### 4. Work Plan: Organization and Summary of Major Work Elements

Successful execution of the Collider Run IIa Plan for FY2003 is the responsibility of the Fermilab Beams Division. The plan was prepared, and will be executed, under the auspices of the Beams Division Deputy Head serving in his capacity as Run IIa Project Leader. Execution of the plan will be undertaken primarily by Beams Division personnel with significant assistance from personnel assigned in the Particle Physics, Technical, and Computing Divisions.

The work is organized into a number of Level II projects. These Level II projects are listed below along with the office holding responsibility for project definition and execution:

Proton Source – Proton Source Department Head
Antiproton Source – Antiproton Source Department Head
Main Injector – Main Injector Department Head
Tevatron – Tevatron Department Head
Recycler – Main Injector Department Head
Beam Transfers – Beam Transfer Coordinator
Shot Data Analysis – Shot Analysis Coordinator
Reliability – Beams Division Associate Head for Engineering

All above indicated positions are currently filled. Overall coordination is provided by the Run IIa Project Leader.

Each level II project is broken down into a number of level III projects. The Recycler Project is further broken down into level IV projects. Currently there are 109 level III/IV projects defined. Associated with each level III/IV project is the following information:

- Responsible person
- Projected impact on collider performance
- Description
- Current status
- Uncertainties

All but 7 level III/IV tasks have responsible person positions filled at this time. Each level III/IV project is broken down into a series of tasks with the following information:

- Resource requirements (cost, personnel, associated beam studies)
- Start date
- Duration

All work included in the above described tasks is being captured in a resource loaded, linked, schedule. This schedule will be used to monitor and plan the execution of work in support of Run II during FY2003. It will not be used to track financial status—this will be tracked by the already existent Beams Division accounting system.

Oversight of performance relative to the plan will be monitored by a number of committees within Fermilab including:

Run II Steering Committee – internal Beams Division committee. Reports to Beams Division Head

Run II Advisory Committee – internal Fermilab committee. Reports to Fermilab Director.

Run II Strategy Group—internal Fermilab committee, including spokespersons of experimental collaborations. Reports to Fermilab Director

Accelerator Advisory Committee – external committee. Reports to Fermilab Director

#### Summary of Major Work Elements

Major technical elements (level III/IV projects) of the plan are summarized in the accompanying table.

	Level II Project		Level III Project	Level IV Project	Project Manager
1	Beamlines				V. Lebedev
		1	A150/P150 beamlines		V. Lebedev
		2	AP3/1/P2/P1 8 GeV beamline		V. Lebedev
		3	120 GeV beamline		V. Lebedev
2	Main Injector				S. Mishra
		1	Investigations on longitudinal emittance growth		D. Wildman
		2	53 MHz beamloading compensation for phars		I. Kourbanis
		3	additional 53 MHz beamloading compensation		Ioanis Kourbanis
		4	2.5 MHz pbar acceleration		C. Bhat
		5	Injection dampers		B. Foster
		6	2.5/7.5 MHz BPM's in MI		?
		7	General Diagnostics		S. Pordes
		8	Tunemeter for pbars		?
		9	Improvement in MI ramp and closure programs		G. Wu
		10	Tune and chromaticity calculation programs		?
3	Pbar Source				D. McGinnis
		1	Return ramp from shot lattice		S. Werkema
		2	Debuncher momentum cooling		P. Derwent
		3	core-stacktail compensation legs		P. Derwent
		4	bands 2&3 transverse cooling equalizers		D. McGinnis
		5	AP1 bunch length monitor		D. Peterson
		6	Debuncher moveable quad stands		K. Gollwitzer
		7	1-Q damper in Accumulator		D. Peterson
		8	transverse compensation in stacktail		S. Werkema

		9	transverse debuncher notch filters for bands 1&2	R. Pasquinelli
		10	Accumulator Flying Wires	V. Nagaslaev
		11	Accumulator quadrupole pickup	V. Nagaslaev
4	Proton Source			R. Webber
		1	Booster performance investigations	R. Webber
		2	Ramped Dipole Correctors	E. Prebys
		3	Phase Lock Improvements	R. Webber
		4	Longitudinal Dampers	Bill Pellico
		5	Collimation System	A. Chen
		6	Transverse instability investigations	?
		7	Booster operational performance monitoring	P.Kasper
		8	400 MeV dp/p monitor and bunch length monitor	B. Pellico
		9	400 MeV line BPM D/A	R. Webber
		10	MI-8 line multiwire emittance measurement	?
5	Reliability			P. Czarapata
		1	VFC	D. Wolff
		2	Wet engines	J. Theilacker
		3	Cold compressor bearings	J. Theilacker
		4	Compressor starters	J. Theilacker
		5	PEI transformers	J. Lentz
		6	Kicker ceramic beamtube	C. Jensen
		7	Controls equipment	J. Patrick
		8	Other vulnerabilities	T. Dombeck
		9	Ongoing assessment of downtime and failures	P. Czarapata
6	SDA			J. Slaughter
		1	Inputs to SDA and SDA Editor	M. Church
		2	Data acquisition engines	K. Cahill
		3	Servlet interface and calibrations	T. Bolshakov
		4	Scaler viewer, plot viewer, Report Writer	J. Slaughter
		5	OSDA interface	P. Lebrun
		6	Standard tables and plots	J. Slaughter
		7	Store checker	J. Slaughter
		8	Shot analysis instrumentation	J. Slaughter/ P. Lebrun
		9	Shot analysis beams	M. Syphers
		10	longterm storage for lumberjack data	P. Lebrun

		11	Data acquisition application for dedicated studies		V. Lebedev
7	Tevatron				V. Shiltsev
		1	Transverse dampers		J. Steimel
		2	Injection dampers		J. Steimel
		3	C0 Lambertson replacement		P. Garbincius
		4	A0 straight section modification		M. Martens
		5	operational orbit smoothing		M. Martens
		6	Beam-beam studies and calculations		T. Sen
		7	Instability studies		P. Ivanov
		8	150 GeV tune & coupling drift; b2 unwind		M. Martens
		9	TEL		V. Shiltsev
		10	Schottky detector at E17		R. Pasquinelli
		11	Tune feedback		CY Tan
		12	Longitudinal dampers		J. Steimel
		13	Synch Lite monitor		H. Cheung
		14	Orbit motion spectrometer		X. Zhang
		15	Investigation of RF noise		V. Lebedev
		16	Tevatron vacuum		B. Hanna
		17	Losses/collimators		R. Moore
		18	SBD, FW, FBI		S. Pordes
		19	Pbar tunemeter		CY Tan
8	Recycler				S. Mishra
		1	Mechanical Modifications		P. Limon
		1		Vacuum Upgrade	T. Anderson
		2		Vacuum experiments	H. Piekarz
		3		NuMI Coordination	J. Misek
		4		Ecool Coordination	J. Leibfritz
		5		MI Modifications	J. Liebfritz
		2	Beams & Studies Coordination		S. Mishra
		1		Beam Lines	A. Marchionni
		2		RF manipulations	C. Bhat
		3		Long. Emitt. Growth	C. Bhat
			+		
		4		BPM Studies	M. Hu
		5		BPM Studies MI Effects	M. Hu S. Pruss
		5	Instrumentation & Software	MI Effects	S. Pruss
		5	Instrumentation & Software  Instrumentation	MI Effects	S. Pruss M-J. Yang
		5 6 3		MI Effects	S. Pruss M-J. Yang J. Butler P. Wilson, S.
		5 6 3 3a		MI Effects Lattice Mods	S. Pruss M-J. Yang J. Butler P. Wilson, S. Zimmerman
		5 6 3 3a		MI Effects Lattice Mods BPMs	S. Pruss M-J. Yang J. Butler P. Wilson, S. Zimmerman M. Hu
		5 6 3 3a 1 2		MI Effects Lattice Mods  BPMs IPMs	S. Pruss M-J. Yang J. Butler P. Wilson, S. Zimmerman M. Hu M. Hu
		5 6 3 3a 1 2 3		MI Effects Lattice Mods  BPMs IPMs Flying wires	S. Pruss M-J. Yang J. Butler P. Wilson, S. Zimmerman M. Hu M. Hu A. Marchionni

7		Inj. Dampers	G.W. Foster
31	Software		D. Petravick
1		BPMs	M. Hu
2		IPMs	M. Hu
3		Flying Wires	A. Marchionni
4		Multi-wires	M-J. Yang
5		BLT	D. Broemmelsiek
6		Schottky	D. Broemmelsiek
7		Inj. Dampers	G.W. Foster
8		Pbar extraction	D. Broemmelsiek
9		Corr.Element Cntrl	G. Wu
10	)	Emitt. Measurements	K. Gounder
11		System Software	?
12	2	Database	C. Gattuso
13	}	Gen'l Applic. Pages	G. Wu
4	Stochastic Cooling		R. Pasquinelli
1		Measure cooling rate	D. Broemmelsiek
2		Heating terms	R. Pasquinelli
3		Simulations	?

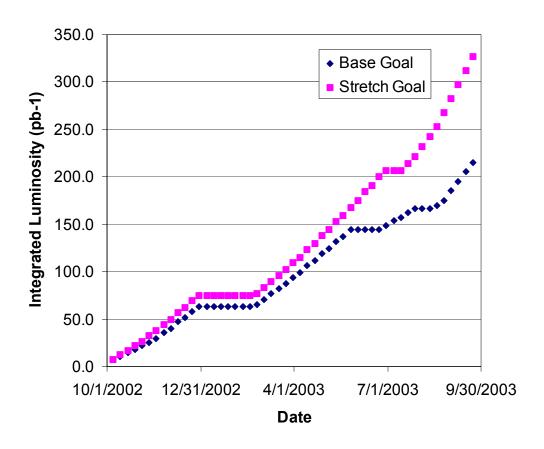
#### 5. Running schedule and luminosity profile

A model of the running schedule and luminosity performance for the Tevatron Collider in FY2003 has been constructed on the basis of the schedule for completion of tasks outlined above, an evaluation of likely performance impacts associated with the completion of these tasks, and the operating schedule described in Section 2. The model also includes a parameterization of luminosity performance in terms of performance of individual systems within the accelerator complex, allowing an overall collider performance to be deduced from improvements in subsystem performance. On the basis of this model a peak and integrated luminosity is projected on a weekly basis for FY2003. While it is not reasonable to expect actual performance to conform on a weekly level, one should expect that the model to provide an approximate picture of performance averaged over the entire year.

The weekly performance projections are contained in the accompanying graph and two spreadsheets. The "base goals" graph and spreadsheet incorporate the improvements described in Section 4, but do not necessarily take full credit for each associated performance enhancement either in terms of schedule or impact. They assume that currently unidentified effects or faults could impact performance. Incorporation of these items is based on experience in operating the Tevatron collider over the last decade. A total of 39 weeks of operations in collider mode is projected in the base scenario. Total integrated luminosity in FY03 is 215 pb<sup>-1</sup>. Fermilab is confident that base goals, 200 pb<sup>-1</sup> and 10 pb<sup>-1</sup>/week be the end of the period, can be met.

The "stretch goals" incorporate the same elements as the base goals but takes a more optimistic view. They represent how performance could evolve if everything went well, without any missteps or unanticipated difficulties. A total of 43 weeks of operations is projected in the stretch scenario. Total integrated luminosity in FY03 is 327 pb<sup>-1</sup>. Fermilab is committed to trying to meet the stretch goals.

# **FY03 Integrated Luminosity**



### Weekly Schedule (Base Goals)

	Hours			Antiprotons			Protons		Weekly Luminosity		Total
	Actual St	ore Number	of Pba	ars at Low		Protons a		mittance at	Typical Initial		Integrated Luminosity
Week of	hours	Stores		a (E9)	at Low be			ow beta	Luminosity	Luminosity (pb <sup>-1</sup> )	since 9/30/02
			nctional pbar								
9/30/200		87	5.8	48	5 16	5.7	6032	25.4	2.4E+31	3.9	3.9
		columns S, Y		4-	- 4		0000	00.7	0.05.04	0.0	
10/7/200		65	4.3	47 nd 7) Antii		า.ง doading compens	6222	23.7	2.6E+31	3.2	7.1
10/14/200		69	4.6	110 Z). ATIUJ 52			6408	23.7	3.0E+31	3.9	11.0
10/14/200		65	4.3	52			6408	23.7	3.0E+31	3.6	
10/28/200		65	4.3	52			6408	23.7	3.0E+31	3.6	
11/4/200		69	4.6	52			6408	23.7	3.0E+31	3.9	
11/11/200	2	65	4.3	52	2 15	5.6	6408	23.7	3.0E+31	3.6	25.8
Tevatron to	ransverse d	lampers (col	umns T and 2	<u>z</u> )							
11/18/200		65	4.3	53			7041	24.14	3.3E+31	4.0	
11/25/200		91	6.1	57			7041	24.14	3.6E+31	6.0	35.9
			: rate +20%,				7044	04.44	2.05.24	4.0	40.5
12/2/200		65	4.3	62			7041 7041	24.14	3.8E+31	4.6	
12/9/200 12/16/200		87 69	5.8 4.6	65 63			7041	24.14 24.14	4.0E+31 3.9E+31	6.4 5.0	
12/10/200		87	5.8	65			7041	24.14	4.0E+31	6.4	
12/30/200		69	4.6	63			7041	24.14	3.9E+31	5.0	
			C-0 modificati						0.02 0 1	0.0	00.1
1/6/200		0	0.0	,						0.0	63.4
1/13/200	3	0	0.0							0.0	63.4
1/20/200	3	0	0.0							0.0	63.4
1/27/200		0	0.0							0.0	
2/3/200		0	0.0							0.0	
2/10/200		0	0.0							0.0	63.4
Restart per		•								0.0	00.4
2/17/200		0 39	0.0 2.6	54	0 10		7041	24.14	3.4E+31	0.0 2.4	
2/24/200 Stacking in			2.0 nd increase h				7041	24.14	3.4⊑+31	2.4	65.8
3/3/200		65	4.3	70 70 XIII			7212	24.14	4.2E+31	5.1	70.9
3/10/200		69	4.6	70			7212	24.14	4.3E+31	5.5	
3/17/200		69	4.6	70			7212	24.14	4.3E+31	5.5	
3/24/200		69	4.6	70			7212	24.14	4.3E+31	5.5	
Antiproton	injection da	ampers (colu	ımn S)								
3/31/200		69	4.6	74			7212	24.14	4.8E+31	6.2	93.7
			ons/week to R								
4/7/200		69	4.6	63		5.5	7212	24.14	4.1E+31	5.3	
4/14/200		91	6.1	69			7212	24.14	4.4E+31	7.5	
4/21/200		69	4.6	63			7212	24.14	4.1E+31	5.3	
4/28/200 5/5/200		91 69	6.1 4.6	69 63			7212 7212	24.14 24.14	4.4E+31 4.1E+31	7.5 5.3	
5/12/200		91	6.1	69		i.5	7212	24.14	4.4E+31	7.5	
5/19/200		69	4.6	63			7212	24.14	4.1E+31	5.3	
5/26/200		91	6.1	69			7212	24.14	4.4E+31	7.5	
Downgrade	e reliability	factor June-	August (colun	nn F)							
Assume fo	ur weeks a	owntime in s	summer for eq		ilure and/or	required mainten	ance				
6/2/200		0	0.0							0.0	
6/9/200		0	0.0							0.0	
6/16/200		0	0.0							0.0	
6/23/200 6/30/200		0 53	0.0 3.6	57	4 15		7212	24.14	3.7E+31	0.0 3.6	
7/7/200		70	4.7	64			7212	24.14	4.1E+31	5.3	
7/14/200		53	3.6	57			7212	24.14	4.1E+31 3.7E+31	3.6	
7/21/200		70	4.7	64			7212	24.14	4.1E+31	5.3	
7/28/200		53	3.6	57			7212	24.14	3.7E+31	3.6	
		o operations		٠.				*****	01	0.0	
8/4/200		0	0.0							0.0	166.1
8/11/200	3	0	0.0							0.0	166.1
8/18/200		37	2.4	85			7212	24.14	5.4E+31	3.7	
8/25/200		53	3.6	85	5 15	5.5	7212	24.14	5.4E+31	5.4	175.3
-	improveme		0.5				7040	04.44	F 4F 21		40= 0
9/1/200		98	6.5	85			7212	24.14	5.4E+31	10.0	
9/8/200 9/15/200		98 98	6.5 6.5	85 85			7212 7212	24.14 24.14	5.4E+31 5.4E+31	10.0 10.0	
9/15/200		98	6.5	85			7212	24.14	5.4E+31 5.4E+31	10.0	
5.22,200	-			55	_ 10			_7.17	J	10.0	210.1

## Weekly Schedule (Stretch Goals)

		Hours		Antip	rotons		Prot	ons	Weekl	y Luminosity	Total
	Actual S	tore Number	rof	Pbars at Low		Protons at		Emittance at		Integrated	Integrated Luminosity
Week of	hours	Stores		beta (E9)	at Low beta	beta (E9)		Low beta	Luminosity	Luminosity (pb <sup>-1</sup> )	since 9/30/02
				pbar BLT - colu							
9/30/200		87	5.8	48	5 16.7		6032	25.4	2.4E+31	3.9	3.9
10/7/200		columns S, \ 65	() 4.3	47	7 15.6		6222	23.7	2.6E+31	3.2	7.1
				47 s T and Z). Antij					2.0E+31	3.2	7.1
10/14/200		91	6.1	5 1 anu 2). Anu 58			6687	23.7	3.5E+31	5.9	13.0
10/21/200		65	4.3	54			6687	23.7	3.3E+31	3.9	
10/28/200		87	5.8	57			6687	23.7	3.4E+31	5.5	22.5
11/4/200	)2	69	4.6	55	4 15.6		6687	23.7	3.3E+31	4.3	26.8
		dampers (co									
11/11/200		87	5.8	59			7400	24.14	3.9E+31	6.3	
11/18/200		65	4.3	56			7400	24.14	3.7E+31	4.5	
11/25/200		91	6.1	60 00/ amittanaa			7400	24.14	3.9E+31	6.7	44.2
12/2/200		nprovements 65	4.3	0%, emittance - 65		,	7400	24.14	4.2E+31	5.1	49.3
12/9/200		87	5.8	68			7400	24.14	4.4E+31	7.2	
12/16/200		69	4.6	66			7400	24.14	4.3E+31	5.5	
12/23/200		87	5.8	68			7400	24.14	4.4E+31	7.2	
12/30/200		69	4.6	66	6 16.1		7400	24.14	4.3E+31	5.5	74.7
		or Recycler,	C-0 modi	ifications, and n							
1/6/200		0	0.0							0.0	
1/13/200		0	0.0							0.0	
1/20/200		0	0.0							0.0	
1/27/200		0	0.0							0.0	
2/3/200		0	0.0							0.0	
2/10/200 Restart per		U	0.0							0.0	74.7
2/17/200		0	0.0							0.0	74.7
2/24/200		39	2.6	57	9 16.1		7400	24.14	3.7E+31	2.7	
				se helix by 30%					0.72.01		****
3/3/200		65	4.3	76			7466	23.92	4.8E+31	5.9	83.3
3/10/200	)3	69	4.6	77	3 17.5	i	7466	23.92	4.9E+31	6.3	89.6
3/17/200	)3	69	4.6	77	3 17.5	i	7466	23.92	4.9E+31	6.3	95.9
3/24/200		69	4.6	77	3 17.5		7466	23.92	4.9E+31	6.3	102.2
		lampers (colu									400.4
3/31/200		69	4.6	80			7466	23.92	5.3E+31	6.9	109.1
4/7/200		A of antiproto 69	ons/week 4.6	to Recycler int 68			7735	24.14	4.7E+31	6.1	115.2
4/14/200		91	6.1	74			7735	24.14	5.1E+31	8.6	
4/21/200		69	4.6	68			7735	24.14	4.7E+31	6.1	
4/28/200		91	6.1	74			7735	24.14	5.1E+31	8.6	
5/5/200		69	4.6	68			7735	24.14	4.7E+31	6.1	
5/12/200		91	6.1	74	5 15.5		7735	24.14	5.1E+31	8.6	153.3
5/19/200	)3	69	4.6	68	9 15.5		7735	24.14	4.7E+31	6.1	159.4
5/26/200		91	6.1	74	5 15.5		7735	24.14	5.1E+31	8.6	168.0
		ents (column									
6/2/200		75	5.0	70			7735	24.14	4.8E+31	6.7	
6/9/200		98	6.5	75			7735	24.14	5.2E+31	9.5	
6/16/200		75	5.0	70			7735	24.14 24.14	4.8E+31	6.7	
6/23/200 6/30/200		98 75	6.5 5.0	75 70			7735 7735	24.14	5.2E+31 4.8E+31	9.5 6.7	
Integrate F		73	5.0	70	0 13.3		1133	24.14	4.0L · 31	0.7	207.1
7/7/200		0	0.0							0.0	207.1
7/14/200		0	0.0							0.0	
7/21/200		51	3.4	111	3 15.5		7735	24.14	7.6E+31	7.3	
7/28/200		51	3.4	111			7735	24.14	7.6E+31	7.3	
8/4/200		75	5.0	111			7735	24.14	7.6E+31	10.6	
8/11/200		75	5.0	111	3 15.5		7735	24.14	7.6E+31	10.6	242.9
		vork as plann		4			7705				
8/18/200		75	5.0	111			7735	24.14	7.6E+31	10.6	
8/25/200		98 105	6.5	111			7735	24.14	7.6E+31	13.9	
9/1/200 9/8/200		105 105	7.0 7.0	111 111			7735 7735	24.14 24.14	7.6E+31 7.6E+31	14.9 14.9	
9/15/200		105	7.0	111			7735	24.14	7.6E+31	14.9	
9/22/200		105	7.0	111			7735	24.14	7.6E+31	14.9	
	-							=			520.0